

Modified Feature DescriptorBased Approach to Recognize Surgically Altered Human Faces

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Abstract—Plastic Surgery is being cited as one of the major challenges for face recognition issues. Plastic surgery method significantly alters the facial regions by modifying the appearances, facial features, textures, both locally and globally. These features greatly affect routine of algorithm on the database of plastic surgery, which contains both local and global face images. The study clearly depicts how the commonly used algorithms suffer in identifying and reflecting the modifications done by plastic surgery procedures. For finding the closeness between the pre-surgical face and post-surgical face closeness between the pre and post-surgical faces are found out by extracting the nose, eyes and lips feature. In this paper, an attempt has been made to develop a novel technique to recognize surgically altered images using Modified Feature Descriptor (MFD) technique and Adaptive Feature Matching (AFM). MFD consist of two steps, firstly an encoding scheme is devised that compresses high-dimensional dense features into a compact representation by maximizing the intrauser correlation. Secondly AFM is developed for effective classification. The proposed system is compared with two state of the art techniques to recognize surgically altered human faces are firstly Local Binary Pattern and Local Derivative Pattern based approach and secondly Local Binary Pattern and Principle Component Analysis based approach. The proposed system is validated using IIIT-Delhi Plastic Surgery Face Database.

Keywords—Modified Feature Descriptor Local Binary Pattern; Local Derivative Pattern; Principle Component Analysis

I. INTRODUCTION

Facial plastic surgery has gained great importance in the past decade with the advancements in the technology. Researchers have used Dual-attributes techniques which are found to be robust for the facial appearance changes, especially caused by cosmetics or makeup [1]-[2]. Attribute-

based methods have shown successful applications in a couple of computer vision problems such as object recognition and face verification. But, using attributes, there exist no approach which effectively addresses the problem of facial cosmetics in specific [3]. Dual-attributes are learnt separately from surgically altered faces and then the facial similarity is measured using shared attribute scan, irrespective of surgical changes. Instead of matching the pre and post-surgical faces directly with low level features, Dual-attributes match the pre and post-surgical faces in a semantic level [4]. Another approach is Edge based Gabor Feature presented in [5]-[8] for representing the faces which are changed by plastic surgery. In this approach face representation is addressed using intra-face dissimilarity problem, which occurs during plastic surgery. Structural Similarity Index weighted multiple patch fusions is another approach which doesn't require any training process or background information's [9]. But the in patch fusion technique there is high demand for discriminative weights and holistic geometric information extraction which is practically not feasible on surgically altered images [10]-[11].

Two latest techniques used to recognize surgically altered human faces are firstly Local Binary Pattern (LBP) and Local Derivative Pattern (LDP) based approach and secondly Local Binary Pattern (LBP) and Principle Component Analysis (PCA) based approach [12]-[17]. Both these approaches are explained in Section II. Section III presents the proposed system, Section IV presents the Results and Discussions and Section V draws the Conclusion.

II. EXISTING SYSTEM

A. Recognizing surgically altered faces using LBP and LDP

Pre-surgical and post-surgical features are extracted using LBP and LDP. Histogram values are extracted from LDP feature, which will be used for mapping the dataset feature. Modules for recognizing surgically altered faces using LBP and LDP include:

- Face granulation
- LBP and LDP feature extraction
- Histogram matching and Micro Pattern Generation
- **Face granulation:**In face granulation, first we segment the face from the given image, by converting the given image as YCbCr. We then detect the skin region from the image, after which the morphological operation will be applied for extracting the face from the given image.
- **LBP and LDP feature extraction:**Initially, the image will be separated as patches, where LBP will be applied separately for each patch. The n th-order LDP can be encoded by $(n-1)$ th order local derivative, hence to calculate second-order LDP we must first calculate first-order local derivative.
- **Histogram and Micro pattern Generation:**Herewe calculate the first derivation of each pixel, and then multiples of the first derivations is calculated between operating pixel and its neighbors which is shown in Fig. 1.

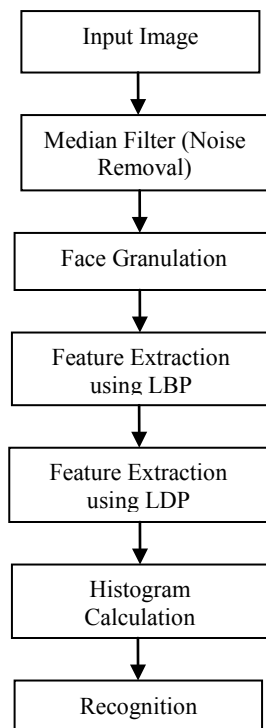


Fig. 1 Recognizing surgically altered human faces using LBP and LDP

B. Recognizing surgically altered faces using LBP and PCA

Feature extraction of pre-surgical and post-surgical humane faces is performed using LBP and PCA. Histogram values will be extracted using PCA. Classification will be performed

using Support Vector Machine (SVM). Modules for recognizing surgically altered faces using LBP and LDP include:

- Pre-processing using median filter.
- Feature extraction using LBP and PCA
- Classification using SVM
- **Pre-processing using median filter:**The input image is resized to 256x256 and median filter is applied to remove the noises.
- **Feature Extraction using LBP and PCA:**The face image is separated into patches, LBP and PCA features are extracted from each patch. Statistical features such as mean, standard deviation and entropy will be also calculated for each patch.
- **Classification using SVM:**SVM classifier is employed to find out whether the face of a person obtained from the input image is surgically altered or not. The SVM classifier trains and arranges the feature vectors in hyper planes. The virtual hyper plane divides the image into two categories, i.e. test and train. If majority of features lie on the side of hyper plane where images with surgically altered human face appear then the image belongs to test class which is shown in Fig. 2.

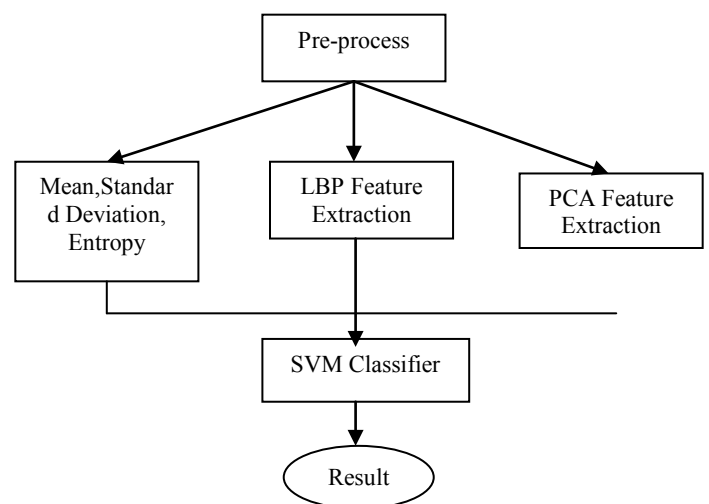


Fig. 2 Recognizing surgically altered human faces using LBP and PCA

III. PROPOSED SYSTEM

A novel technique to recognize surgically altered human face images is proposed using Modified Feature Descriptor (MFD) technique and Adaptive Feature Matching (AFM).

A. Modified Feature Descriptor

Modified Feature Descriptor (MFD) consists of two steps: Pre-processing, Block Separation and Line Patch Segmentation, Feature Extraction and Feature Encoding.

- **Pre-processing and Block Separation and Line Patch Segmentation:**Pre-processing is performed using Gaussian filter which removes noise. The pre-processed image is subject to Block Separation which divides the given input image into 4 blocks. Each of the 4 blocks is segmented using Line Patch Segment technique.

- **Feature Extraction and Feature Encoding:** After Line Patch Segmentation we consider high-dimensional facial features, these contain more information than low-dimensional ones. High-dimensional facial elements can be obtained utilizing both dense sampling landmark and multi-scale procedures: Scale-Invariant Feature Transform (SIFT), Local Binary Patter (LBP), Histogram of Oriented Gradients (HOG). But high-dimensional facial features are computational complex. For example projecting 100K-dimensional facial elements to 1K-dimensions requires 100M floating point multiplications, hence we subsequently propose a effective compression feature encoding system that transforms dense features into a compact features representation, while in the same time upgrading the discriminating power.

B. Adaptive Feature Matching

Adaptive Feature Matching (AFM) consists of Sampling the Data and Developing Linear Sub-Classifer, Multi-Support Vector Machine (SVM)

- **Sampling the Data:** Entire training dataset needs to be sampled completely and feature pairs from the same subject needs to be sampled the same time. We can construct a random training subset as follows: can be sampled at the same time, the random training subsets are constructed as follows:
 - Consider an sampling indicator t and initialize $t = [0 \dots 0] \in \mathbb{R}^{1 \times 2N}$
 - An index k is randomly selected which condition $k \in [1, 2N]$ such that $t(k) = 0$
 - From vertex k we now take M -nearest neighbors such that K different subjects are covered by the selected faces.
 - Incorporate data points that are not in the M -nearest neighbors of vertex k
 - Update $t : t(j) \leftarrow 1$ where $j = \{\text{selected data points}\}$.
 - Go to step (b) until $t(k) = 1$ for $k \in [1, 2N]$
- **Developing Linear Sub-Classifer:** After the data is sampled a linear sub-classifier is designed as follows:
 - Long features are divided into several slices of equal length.
 - Unified subspace analysis method is applied for the n^{th} sliced features to train a linear model, whose projection matrix and mean vector are denoted.
- **Multi-Support Vector Machine:** The classification of the difficult sample is done in a better way by utilizing classification model which is trained from nearby samples. Also the samples in the local region are linear hence they can be classified efficiently by utilizing the linear classifiers. This overcomes the kernel space and its risk of over fitting. The implementation of the Adaptive matching framework uses Multi-Support Vector Machine to classify the compressed facial representations and adaptively select some Linear Sub-Classifiers.

The Flow Diagram, Class Diagram and E-R Diagram of the proposed system are shown in Fig. 3, Fig. 4 and Fig. 5 respectively.

IV. RESULTS AND DISCUSSION

The proposed system which uses Modified Feature Descriptor (MFD) and Adaptive Feature Matching (AFM) to recognize surgically altered images is implemented using MATLAB 2014. Step by step implementation of LBP and LDP based approach is shown in Fig. 5, LBP and PCA based approach is shown in Fig. 6, MFD and AFM based approach is shown in Fig. 7

Modified Feature Descriptor (MFD) and Adaptive Feature Matching (AFM) based approach to recognize surgically altered faces are validated on IIIT-Delhi Plastic Surgery Face Database which contains 1800 pre and post surgery images pertaining to 900 subjects. For each individual, there are two frontal face images with proper illumination and neutral expression: the first is taken before surgery and the second is taken after surgery. The database contains 519 image pairs corresponding to local surgeries and 381 cases of global surgery. Existing techniques LBP and LDP and LBP and PCA are compared with the proposed technique Modified Feature Descriptor (MFD) and Adaptive Feature Matching (AFM) based approach is tabulated in Table 1.

Table: 1. Face Recognition Rate across surgically altered faces

| Author | Method | Database | Recognition Rate (%) |
|----------------------------|------------------------------|-----------------------------------|----------------------|
| Lakshmiprabha, N.S [9] | LBP, Gabor patterns | IIIT-Delhi Plastic Surgery | 72 |
| Yunlian Sun et al. [11] | SSIM Quality map, SSIM Index | IIIT-Delhi Plastic Surgery | 77.55 |
| Bhatt, H.S et al. [13] | UCLBP, SURF | IIIT-Delhi Plastic Surgery | 78.61 |
| Fernandes, Balaet al. [17] | LBP, LDP, PCA | IIIT-Delhi Plastic Surgery | 87.5 |
| Proposed Method | MFD, AFM | IIIT-Delhi Plastic Surgery | 97.8 |

Table 1 indicates that the proposed method of recognizing faces across surgically altered using Modified Feature Descriptor technique and Adaptive Feature Matching gives the best recognition rate of 97.8% on IIIT-Delhi Plastic Surgery Face Database when compared to all other recognition techniques.

V.CONCLUSION

In this paper, an attempt has been made to develop a novel technique to recognize surgically altered images using Modified Feature Descriptor technique and Adaptive Feature Matching. Modified Feature Descriptor consist of two steps, firstly an encoding scheme is devised that compresses high-dimensional dense features into a compact representation by maximizing the intra user correlation. Secondly AFM is developed for effective classification. The proposed system is compared with two state of the art techniques to recognize surgically altered human faces are firstly Local Binary Pattern and Local Derivative Pattern based approach and secondly Local Binary Pattern and Principle Component Analysis based approach. The proposed system is validated using IIIT-Delhi Plastic Surgery Face Database. From our analysis, it is found that the proposed method of recognizing faces across surgically altered using Modified Feature Descriptor technique and Adaptive Feature Matching gives the best recognition rate of 97.8% on IIIT-Delhi Plastic Surgery Face Database when compared to all other recognition techniques.

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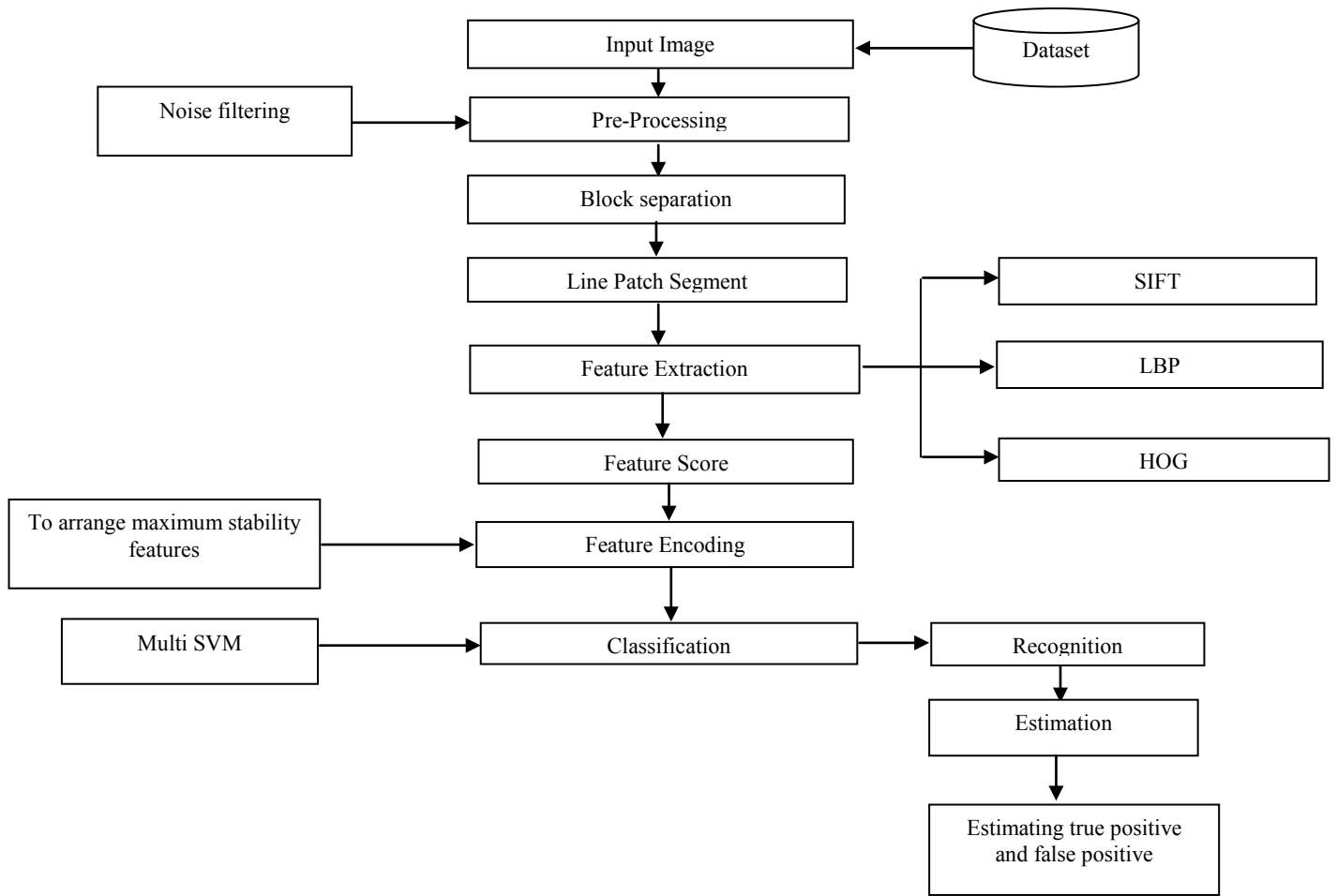


Fig. 3 Flow diagram for recognizing surgically altered faces using MFD and AFM

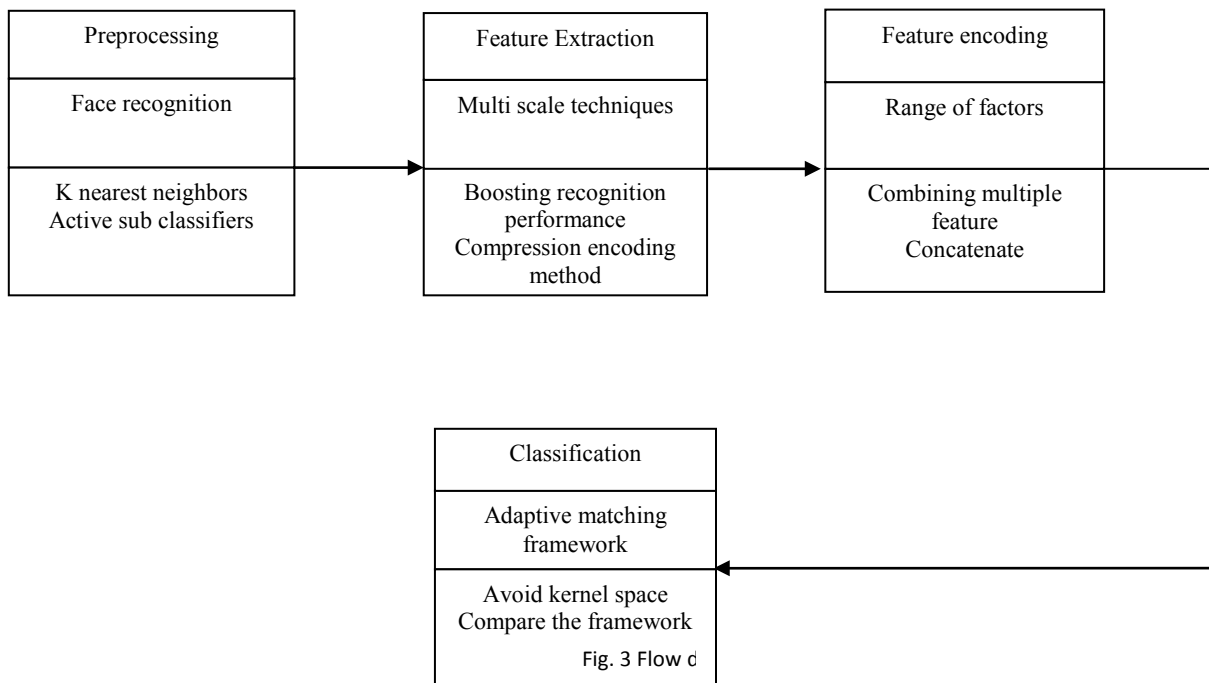


Fig. 4 Class diagram for recognizing surgically altered faces using MFD and AFM

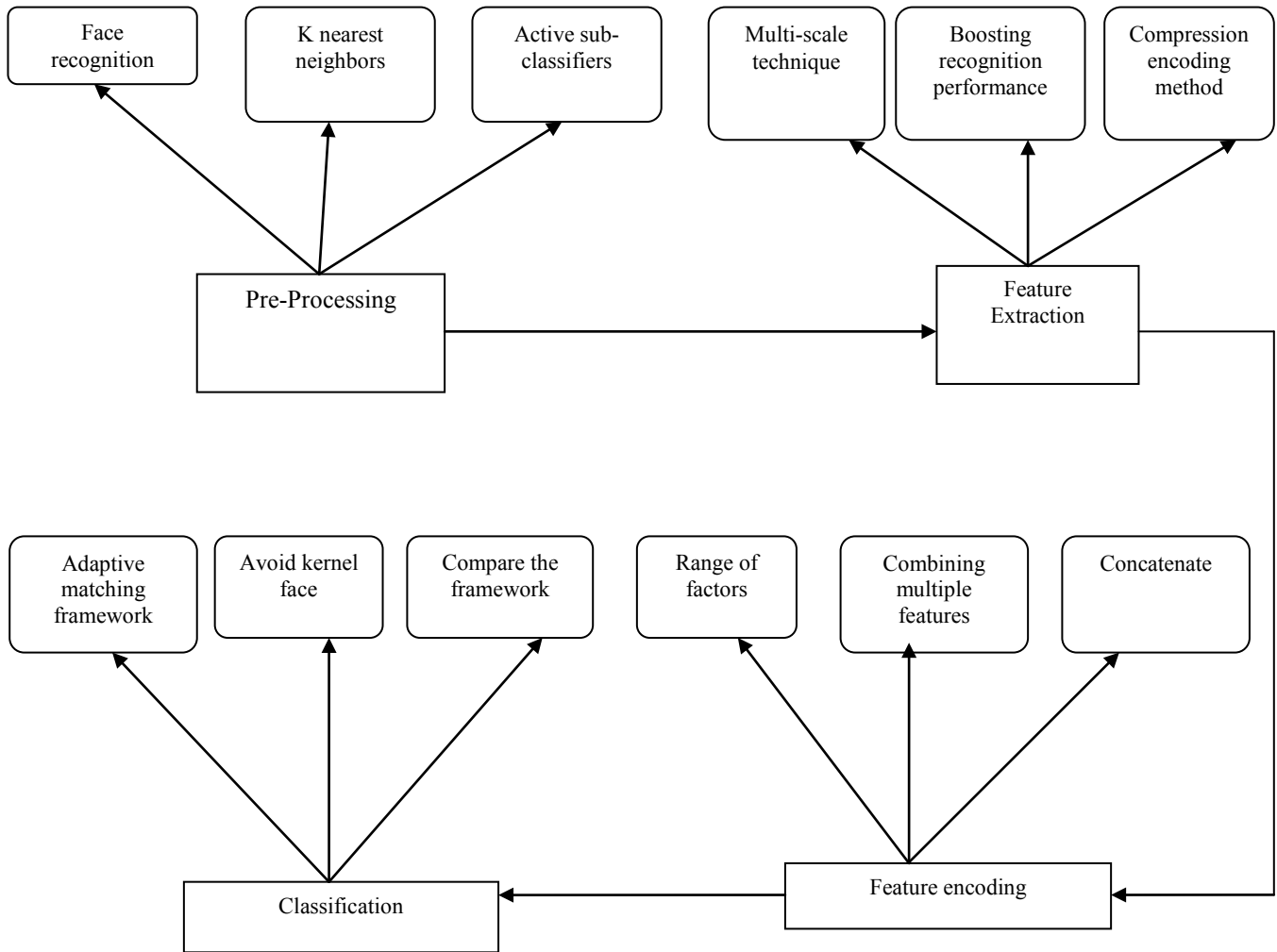


Fig. 5 E-R Diagram for recognizing surgically altered faces using MFD and AFM

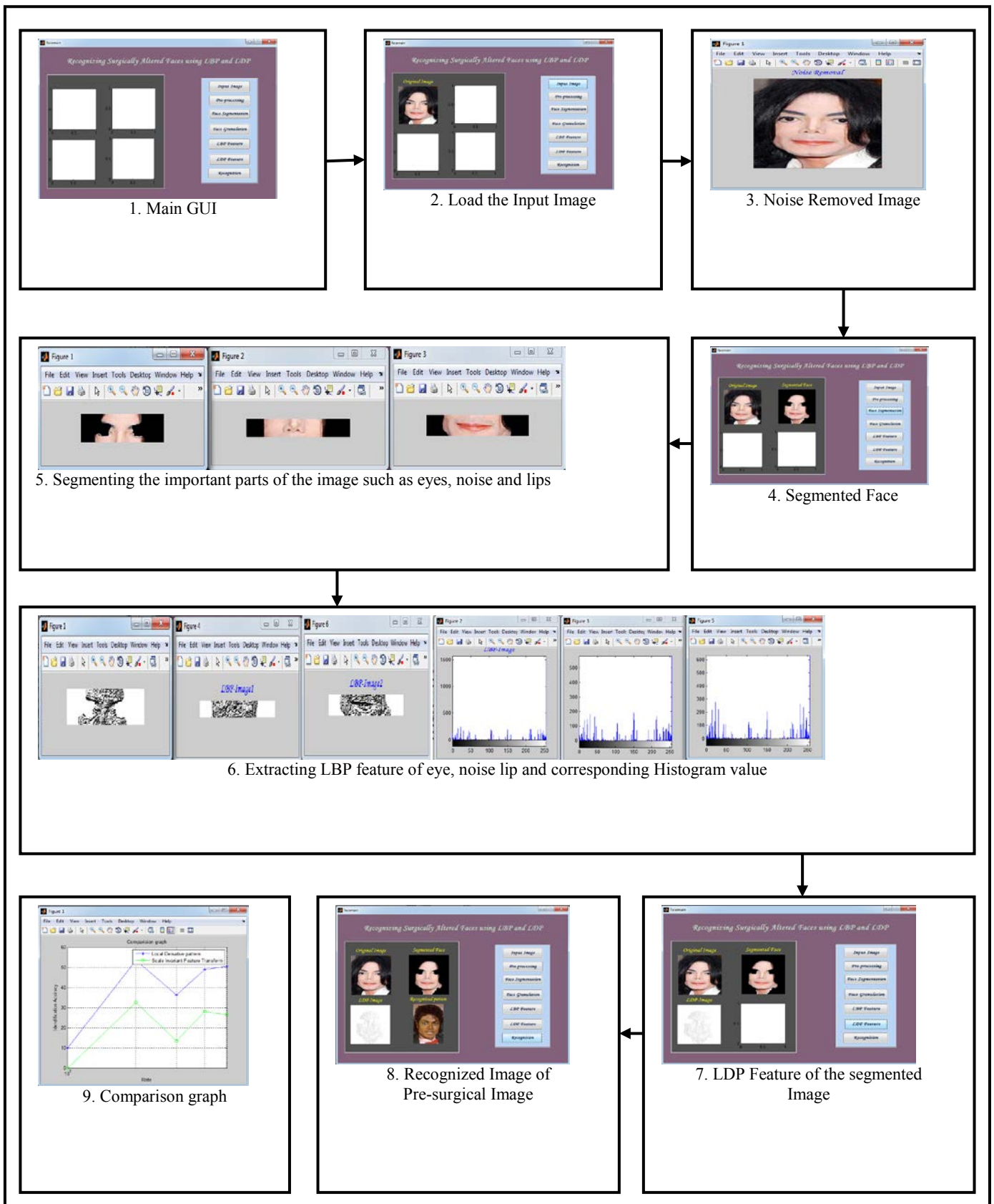


Fig. 5. Recognizing surgically altered faces using LBP and LDP



Fig. 6. Recognizing surgically altered faces using LBP and PCA

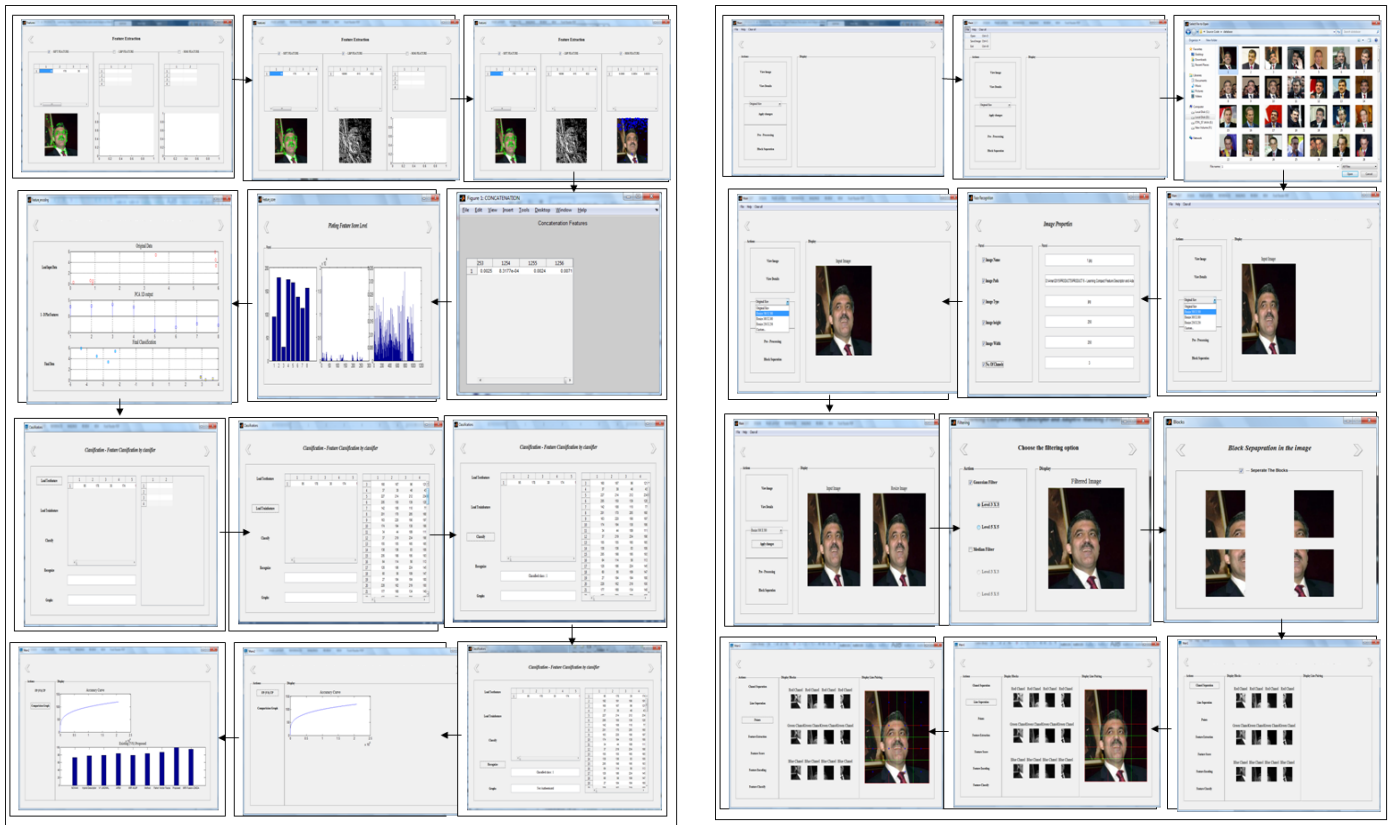


Fig. 7 Recognizing surgically altered faces using MFD and AFM